

## REMARKS/ARGUMENTS

Reconsideration of the subject application, as amended, is respectfully requested.

Several of the claims of the subject application, as amended, are directed to a brushless DC motor or a linear motion device which includes an armature assembly, a field assembly, including permanent magnets each having a length, first and second end magnets each having a length, and pole pieces each having a length. The length of the first and second end magnets is less than the length of the plurality of pole pieces and the length of the plurality of permanent magnets, and the ratios between the length of the plurality of permanent magnets, the length of the first and second end magnets, and the length of the plurality of pole pieces are tailored to achieve a constant force versus stroke characteristic with sinusoidal commutation, or a sinusoidal distribution of a normal component of flux density in an air gap between the armature and field assembly.

Others of the claims are directed to a brushless DC motor or a linear motion device which includes an armature assembly, a field assembly, including permanent magnets each having a length; and pole pieces each having a length. The length of the plurality of pole pieces is two-thirds ( $2/3$ ) the length of the plurality of permanent magnets, so that a constant force versus stroke characteristic is achieved, or a sinusoidal distribution of a normal component of flux density in an air gap between the armature and field assembly is obtained.

Certain dependent claims recite end caps with end pole pieces, where the lengths of the end pole pieces are selected to obtain a sinusoidal force versus entire stroke characteristic.

Claims 1-30 are pending in the subject application. Claims 27-30 are newly added.

New claim 27 is originally filed dependent claim 5 rewritten in independent form to include the limitations of claim 3 and base claim 2, as originally filed, from which claim 5 originally depended. New claim 29 is originally filed claim 6 rewritten in independent form to include the limitations of claim 5 and base claim 2, as originally

filed, from which claim 6 originally depended. New claim 28 depends from claim 27 and recites the limitations of claim 9 as dependent from claims 5, 3 and base claim 2, as originally filed. New claim 30 depends from claim 29 and recites the limitations of claim 10 as dependent from claims 6, 4 and base claim 2, as originally filed, but also adds the limitations of claim 3 as an antecedent basis for the end pole pieces.

Claim 5, as amended, has been rewritten in independent form to incorporate the limitations of base claim 1, and intervening claim 3, as originally filed. Claim 6, as amended, has been rewritten in independent form to incorporate the limitations of base claim 1, and intervening claim 4, as originally filed. Claim 14, as amended, has been rewritten in independent form to incorporate the limitations of base claim 13, as originally filed.

Independent claims 1, 2, 13, 16 and 24, have been amended to recite first and second end magnets having a length less than the lengths of the plurality of permanent magnets and less than the lengths of the plurality of pole pieces. Claim 1 has also been amended to recite a sinusoidal commutation. Claim 24 has also been amended to recite the relative positioning of the end magnet pieces and the end pole pieces, and to substitute commas for semicolons in two locations. Support for these amendments can be found in Figs. 2 and 3, and at page 2, lines 7-9, and page 3, lines 21-24

Dependent claims 8 and 10 have been amended to supply an antecedent basis for the "end pole pieces." Support for this amendment can be found in originally filed claim 3, in Fig. 2, and at page 4, lines 14-19, for example.

**Official Action**

The Examiner has rejected claims 1-26 under 35 U.S.C. §102(b) as anticipated by Petersen, USP 4,363,980, and/or under § 103(a) as unpatentable over Petersen in view of Hirabayashi, USP 5,434,549. The following table summarizes these rejections:

Claims	References
1, 2, 4, 6, 8, 10, 16, 17, and 19	§102(b) Petersen
3, 5, 7, 9, 11-15, 18, and 20-26	§ 103(a) Petersen in view of Hirabayashi

The Examiner's rejections are respectfully traversed.

**§102(b) Petersen -- Claims 1, 2, 4, 6, 8, 10, 16, 17, and 19:**

**Claim 1:**

As to claim 1, one of the positions taken by the Examiner is that the notations X and X'-X, and the accompanying discussion in Petersen, shows that "the ratio between the length of the plurality of permanent magnets (X) and the length of the plurality of pole pieces (X'-X) is tailored to achieve a constant force versus stroke characteristic." Applicant respectfully disagrees. Petersen is simply silent on any relationship between the lengths of the pole piece and magnets as they relate to achieving a constant force versus stroke characteristic. See Office Action, page 2. In fact the purpose of the X and X' notations in Petersen is to compare the distance between adjacent poles as it relates to the location of steel washers to return the armature of the motor to its first position. See Figs. 1 and 3, and col. 5, lines 27-48, for example. There is a fundamental difference between Petersen and embodiments of the present invention disclosed and claimed in the subject application. Petersen describes a single-phase, limited-stroke device with a moving field assembly, whereas embodiments disclosed in the subject application include a multi-phase (for example, three-phase) commutated brushless DC motor with a moving ironless armature. As a result, while Petersen's structure is designed to provide a zone of maximum magnetic flux density in line with effective north pole 70 (see col. 5, lines 1-13), the structure of claim 1 of the subject application is

tailored to achieve a constant force versus stroke characteristic with sinusoidal commutation. For these reasons, it is respectfully submitted that claim 1, and those claims dependent from claim 1, are allowable over Petersen.

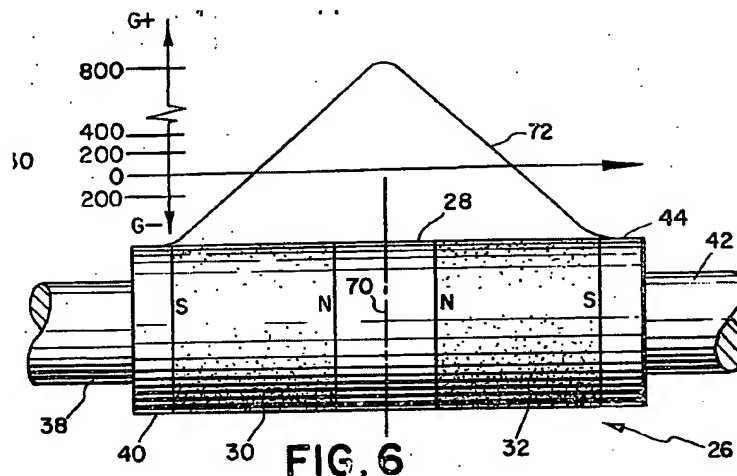
Claim 2:

As to claim 2, one of the positions taken by the Examiner is that Fig. 6 of Petersen shows a sinusoidal distribution of a normal component of flux density in the air gap. See Office Action, page 3. Applicant respectfully disagrees. First of all, in Petersen, at col. 4, line 67 to col. 5, line 13, Petersen's Fig. 6 is described as:

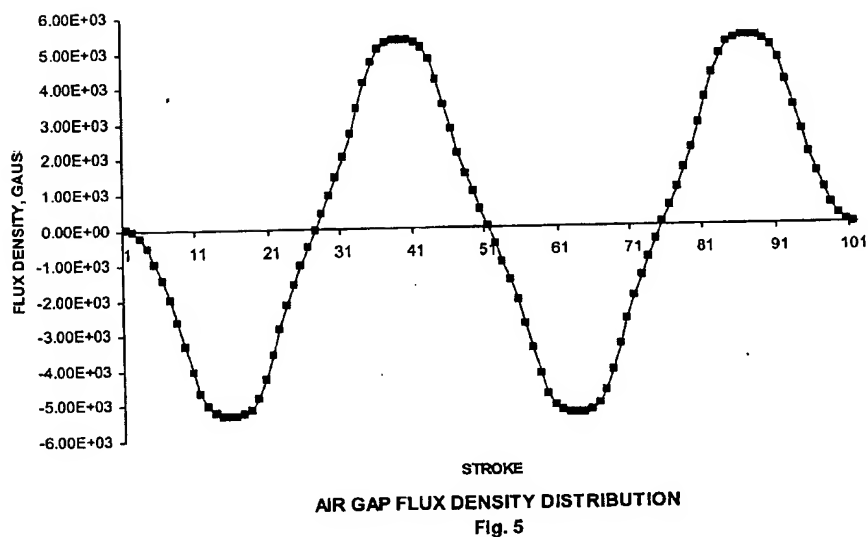
As mentioned hereinabove, the north poles of the magnets 30 and 32 are fixedly secured to the axial end faces 66 and 68 of the steel core 28 in order to provide a zone of maximum magnetic flux density which extends radially outwardly from the central portion of the steel core 28 thereby creating an armature which in effect has three poles, i.e., two south poles designated S in the drawings and a single north pole designated by the broken line 70. This is graphically illustrated in FIG. 6 by the curve 72 which represents the radial flux density of the armature 26 as measured along its axis. It will be noted that the maximum flux density is in line with the effective north pole 70 while the flux density of the magnets 30 and 32 reverses at a point equidistant the south and north poles of each magnet.

It is notable that there is no discussion of shape of the flux distribution provided by Petersen's device, much less a sinusoidal flux distribution. In contrast, in the subject application, Fig. 5 is described as illustrating a sinusoidal distribution of the normal component of the flux density in the air gap in accordance with one embodiment of the invention. See, page 3, lines 8-9, of the subject specification. A comparison of the shape of the curve in Petersen's Fig. 6, with that of the curve in Fig. 5 of the subject application, reveals clear differences, including the limited-stroke nature of Petersen:

**Petersen:**



**Subject Application, Fig. 5:**



It is therefore respectfully submitted, that claims 1 and 2, as originally submitted are patentable over Petersen.

Furthermore, claims 1 and 2 have now been amended to recite first and second end magnets having lengths less than the lengths of the plurality of permanent magnets and the lengths of the plurality of pole pieces. Petersen does not teach such a feature. Claims 1 and 2, as amended, are therefore further patentable over Petersen.

Claims 4, 6, 8 and 10:

As to claims 4, 6, 8 and 10, the Examiner has taken the position that "Petersen also shows all of the limitations of the claimed invention." See Office Action, page 3. Applicant respectfully disagrees. In particular, claim 6 recites that the length of the pole pieces is two-thirds ( $2/3$ ) the length of each of the permanent magnets. In the example provided by Petersen at col., 5, lines 14-27, a magnet length of 0.125 inches and a steel core length of 0.075 inches is recited. This works out to a steel core length which is three-fifths ( $3/5$ ) the length of the permanent magnet. Clearly, three-fifths ( $3/5$ ) is not the same as two thirds ( $2/3$ ).

Claim 6 is therefore patentable over Petersen. Claim 6 has been rewritten in independent form to incorporate the same wording as originally filed. Claim 10 is allowable as depending from claim 6, an allowable base claim. Claims 4 and 8 are allowable as depending from claims 1 or 2, allowable base claims, as set forth above.

New claims 27-30:

As mentioned above, new claims 27 and 29 are independent versions of originally filed claims 6 and 8, respectively, as they ultimately depended from claim 2. These claims recite that the length of the pole pieces is two-thirds ( $2/3$ ) the length of each of the permanent magnets. As discussed above in connection with claim 6, Petersen does not teach or suggest such a limitation. Claims 27 and 29, and claims 28 and 30 as dependent from claims 27 and 29, respectively, are therefore allowable.

Claims 16, 17, and 19:

As to claims 16, 17, and 19, the Examiner has stated that "the method of forming a linear motor would be inherent and obvious since the prior art references meet the structural limitations of the claimed device." Independent claim 16, has been amended to include in the positioning step the positioning of first and second end magnets, where the lengths of the first and second end magnets are less than the length of the plurality of permanent magnets, and less than the length of the plurality of pole pieces. It is respectfully submitted that Petersen does not teach or suggest such a structure, and therefore cannot inherently teach the method of forming such a structure. Claim 16,

and claims 17 and 19 as ultimately dependent from allowable claim 16, are therefore allowable.

**§ 103(a) Petersen in view of Hirabayashi, -- 3, 5, 7, 9, 11-15, 18, and 20-26:**

**Claim 3:**

Regarding claim 3, it is believed that the Examiner cites Petersen for all of the limitations recited in claims 1 or 2, from which claim 3 depends, and cites Hirabayashi (1, 8A, 8B, Figures 19-30) for the limitations recited in claim 3. See Office Action, page 3, paragraph 4. In view of the amendment to claim 1, adding first and second end magnets, and sinusoidal commutation, as discussed above, it is respectfully submitted that claim 3 is allowable over Petersen and Hirabayashi. Neither reference teaches or suggests such a feature. Further, Hirabayashi describes a single-phase limited-stroke device, whereas claim 3 as dependent from claim 1, is directed to a motor tailored to achieve a constant force versus stroke characteristic with sinusoidal commutation.

**Claims 5, 7 and 9:**

The Examiner has asserted in paragraph 4 of the Office Action, that Petersen shows all of the claimed limitations of claims 5, 7 and 9. Claim 5, now in independent form and incorporating the limitations of claims 3 and 1, and claim 9 as dependent from claim 5, recite that the length of the pole pieces is two-thirds ( $2/3$ ) the length of each of the permanent magnets. As discussed above in connection with claim 6, Petersen does not teach or suggest such a feature. Claims 5 and 9 are therefore patentable.

It is respectfully submitted that claim 7 is dependent from claim 3 and ultimately from allowable claims 1 or 2, and therefore allowable.

**Claims 11 and 12:**

The Examiner has taken the position that Hirabayashi shows all of the limitations of claims 11 and 12. See page 4 of the Office Action. Claims 11 and 12 recite that the armature assembly includes a non-magnetic coil base. Both Petersen and Hirabayashi disclose limited-stroke devices with moving field assemblies and armature assemblies incorporating magnetic structures (see, for example, washers 62, 64 in Fig. 1 of

Petersen, and sleeve 1, of Fig. 24 in Hirabayashi). Furthermore, claims 11 and 12 are ultimately dependent from allowable claims 1 or 2, and are therefore also allowable.

Claims 13-15:

As to claims 13-15, the Examiner has indicated that Petersen and Hirabayashi show all of the limitations of the claimed invention, See page 4 of the Office Action.

Claim 13 has been amended to recite first and second end magnets having lengths less than the lengths of the plurality of magnets and the plurality of pole pieces. Neither Petersen nor Hirabayashi teach such a feature. Claim 13, and claim 15 as dependent from claim 13, are therefore allowable over Petersen and Hirabayashi.

Claim 14, now rewritten in independent form and incorporating the limitations as originally filed, recites that the length of the pole pieces is two-thirds ( $2/3$ ) the length of each of the permanent magnets. As set forth in connection with claim 6, above, Petersen does not teach such a feature. Further, it is respectfully submitted that Hirabayashi does not teach such a feature, either. For example, in Fig. 23B of Hirabayashi, a magnet length of 3 mm and a cylindrical magnetic substance length of 1 mm is indicated. This represent a cylindrical magnetic substance length which is one-third ( $1/3$ ) the length of the magnet. Clearly one-third ( $1/3$ ) is not the same as the two-thirds ( $2/3$ ) ratio recited in claim 14. Claim 13 is therefore patentable over Petersen and Hirabayashi.

Claims 18 and 20-26:

Regarding claims 18 and 20-26, the Examiner has indicated that the method of forming a linear motor would be inherent and obvious since the prior art references meet the structural limitations of the claimed device. Claims 18 and 20-26, are ultimately dependent from independent claims 16 or 24, both of which recite first and second end magnets having a length which is less than the length of the plurality of permanent magnets and the length of the plurality of pole pieces. As set forth above in connection with claim 13, for example, neither Petersen nor Hirabayashi teaches such a feature. Claims 18 and 20-26 are therefore allowable over Petersen and Hirabayashi.




Furthermore, claims 20 and 25 further recite that the length of the pole pieces is two-thirds ( $2/3$ ) the length of each of the permanent magnets. As discussed above in connection with claim 14, neither Petersen nor Hirabayashi teach such a feature. Therefore, claims 20 and 25 are further allowable over Petersen and Hirabayashi for this reason.

### CONCLUSION

For the above reasons, it is respectfully submitted that the claims as amended and the newly added claims are patentable, and the Examiner's indication to that end is respectfully solicited.

Respectfully submitted,

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